Appendix B

EMISSIONS INVENTORY METHODOLOGY

SUPPORT DOCUMENTATION

FOR THE

$PM_{2.5}$ REQUEST TO REDESIGNATE TO ATTAINMENT − SOUTHEAST MICHIGAN

March 2011

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1. Introduction

2005 and 2008 Emissions Inventory

Emissions inventory documentation support for the $PM_{2.5}$ Request to Redesignate to Attainment is provided in this appendix. An inventory was prepared for the following Michigan counties: Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne. Mobile estimates for the nonattainment counties were prepared by the Southeast Michigan Council of Governments (SEMCOG). The remaining emission source categories were developed by the Michigan Department of Environmental Quality (MDEQ) and the Lake Michigan Air Director's Consortium (LADCO). LADCO is the Midwest Regional Planning Organization (MRPO) which MDEQ and other Midwest states access for a multitude of technical air quality planning activities. The focus of the inventory effort was to produce emission inventories for the nonattainment year (2005) and the attainment base year (2008). The future year projections (2018 and 2022) take into account existing control measures and measures that are promulgated and known to be on the way. Many of the future year emission estimates for this inventory product were taken from the LADCO Base B Inventory. Where data was not available in the Base B inventory, data from the previous inventory cycle - Base M run was utilized, if appropriate. Procedures used to prepare the Base M inventory product can be found in the *Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document*, prepared by LADCO. LADCO has produced numerous summary reports with state and county total emissions, and posted them on their Internet site at:

http://www.ladco.org/tech/emis/

In a related effort, the 2005 and 2008 Michigan statewide inventories were submitted to the U.S. Environmental Protection Agency (EPA) by the MDEQ pursuant to 40 CFR Part 51, Subpart A – Emissions Inventory Reporting Requirements. Many of the more significant methodologies are described in this appendix.

2018 and 2022 Growth and Control Factors

To assess progress for attaining air quality goals, LADCO uses emission activity growth and control data to forecast emissions from a 2005 nonattainment year and 2008 attainment year inventories to two future years of interest. These future years include 2018 and 2022 (e.g., 2018 is the first milestone for regional haze reasonable progress demonstrations). As a contractor to LADCO, Pechan prepared emission control factors to support forecasting for 2018 and 2022. Because the incremental level of effort required to develop emission activity growth factors for each year over the 2003-2018 period was nominal, Pechan prepared non-electric generating unit (non-EGU) point, area and non-road source growth factors for each year over this entire period.

For the non-EGU point source, stationary area source and Marine, Air and Railroad (MAR) source sectors, the future year emissions for the LADCO states were derived by applying growth and control factors to the base year inventory. Growth factors were based initially on Economical Growth Analysis System (EGAS version 5.0), and were

subsequently modified (for select priority categories) by examining emissions activity data.

The report, *Development of 2005 Base Year Growth and Control Factors for Lake Michigan Air Directors Consortium (LADCO),* describes Pechan's efforts to develop emission growth and control data to support future year air quality modeling by LADCO. The report is organized into a background chapter and:

Chapter II, which describes the development of the emission activity growth data;
Chapter III, which discusses how the emission control data were compiled;
Chapter IV, which describes the preparation of the growth and control factor files;
Chapter V, which identifies projection issues for future consideration; and
Chapter VI, which presents the references consulted in preparing this report.

The Pechan Growth and Control Factor report is too lengthy to be included in this document, but it can be provided upon request or downloaded at:

http://www.ladco.org/reports/technical_support_document/references/ladco_2005_base_yr_growth_and_controls_report_final.pdf

Additional information on the procedures used to project emissions can be found in the *Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document*, prepared by LADCO.

2. EGU Point Sources

2005 EGU Point Source Methodology

The 2005 electrical generation unit (EGU) point source data originated with annual emissions data provided to MDEQ via the Michigan Air Emissions Reporting System (MAERS). Temporal allocation was performed by emission unit, month, day of week, and hour using the procedures described in *Temporally Allocating Emissions with CEM Data for Chemical Transport and SIP Modeling*, available at:

http://www.epa.gov/ttn/chief/conference/ei15/session4/edick.pdf

In addition to the heat input-based temporal profiles described in the paper, separate temporal profiles were developed based on Continuous Emissions Monitoring (CEM) reported emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) and these profiles were used instead of heat input to temporalize annual emissions of the respective pollutants into winter weekday. The CEM data used as the basis of the profiles was for 2004 through 2006, obtained from the EPA Clean Air Markets Division (CAMD) website:

http://cfpub.epa.gov/gdm/index.cfm?fuseaction=iss.progressresults

2008 EGU Point Source Methodology

Year 2008 EGU annual emissions were obtained from MAERS, and temporally adjusted to represent winter weekday as determined from LADCO base B inventory data.

2018 Future Year EGU Point Source Methodology

In developing emission projections for year 2018, consideration was given to both British Thermal Units (BTU) heat input of EGUs within the 7-county area, as well as scheduled facility improvements such as selective catalytic reduction (SCR) of NOx and flue gas desulfurization (FGD) for reduction of SO_2. Because of several utility and industrial EGUs that experience load-shifting among various units, peaker plant use, and occasional shutdowns, total combined BTU heat input data was obtained for the 7-county region for each year of years 2002 – 2008. Correlation and bivariate regression analysis of each year's BTU heat input was then performed to forecast the 7-county future year boiler BTU heat input requirements. The results of this analysis were then used to predict year 2018 BTU heat input and for comparison with other known Integrated Planning Model (IPM) studies by the EPA in their development of the air transport rule. The EPA relied on the IPM model when developing their base case v.4.10 emission projections for years 2012-2050. The EPA's base case v.4.10 IPM model results consider the national Title IV SO_2 cap-and-trade program, NOx SIP Call regional ozone season cap-and-trade program, and all current settlements and state rules. The EPA base case simulation represents conditions without the proposed transport rule and without the rule it replaces, the Clean Air Interstate Rule (CAIR). The predicted BTU heat input obtained from regression forecasts was then compared to the heat input results obtained by the EPA's base case v.4.10 IPM model results and also with LADCO/Visibility Improvement State and Tribal Association of the Southeast (VISTAS) BTU heat input to determine the reasonableness of the prediction. Deductions were made for selective catalytic reduction and flue gas desulfurization at the Detroit Edison Monroe Power Plant that occurred after year 2008. These additional control measures would explain the further reduction in emissions in the future year 2018 emission forecast.

2022 Future Year EGU Point Source Methodology

Bivariate regression analysis was used to forecast future year 2022 energy demand as BTU heat input of EGUs for the 7-county planning area, as was done in the earlier 2018 forecast. Because emission reductions occurred in earlier years between 2008 and 2018, the later 2022 forecast is reflective of expected energy demand growth after control measures were implemented at the Detroit Edison Monroe Power Plant.

3. Non-EGU Point Sources

2005 Non-EGU Point Source Methodologies

The original source of the 2005 point source data is the 2005 Michigan point source emission inventory. This section of the document describes the compilation and processing of point source emission data submitted to comply with the Consolidated Emission Reporting Rule (CERR) for the EPA National Emissions Inventory (NEI) 2005 inventory.

The data originates with the entry of data by the reporting facilities into MAERS. The electronic data received from the reporting facilities is reviewed and compiled by the MDEQ and exported to the fixed-width text version of the National Inventory Format (NIF). After the exported data is loaded into a PostgreSQL database patterned after the Microsoft (MS) Access version of the NIF, the following processing steps and checks are performed.

Both emissions estimated by default calculations in MAERS and any emissions reported by facility operators are maintained in MAERS. For evaluation and quality assurance purposes, both types of records are included in the exports. To avoid double-counting, where a specific process/pollutant has emission records both reported directly by the facility operator and estimated via MAERS calculations, the latter are excluded.

Portable facilities such as asphalt plants report total throughput and emissions, plus operating percentages for each county in which the portable facility was located during the year. From this information, records are generated for each county of operation, and throughput and emissions are apportioned based on the operating percentages reported by county and process. As geographic coordinates for all operating sites are not reported, coordinates corresponding to the centers of the counties of operation are assigned.

As attention has shifted from total particulate to PM_{10} and $PM_{2.5}$, total particulate records are excluded from the reporting requirements.

Over 99.8% of total criteria pollutant emissions are accounted for by emissions reported by the operator. Therefore, exported criteria emissions estimated via MAERS calculations are excluded.

In the site table, where strFacilityCategory is not set in the export, it is set to “01.”

Mandatory geo-coordinate fields were added to the NIF specifications released in December 2003, well after it would have been possible to collect this information from the reporting facilities for 2002 operations. The following values were deemed most often representative and the exported data are updated accordingly for 2002 data:

“strHorizontalCollectionMethodCode” is set to '027'
“strHorizontalAccuracyMeasure” is set to '2000'

“strHorizontalReferenceDatumCode” is set to '001'
“strReferencePointCode” is set to '106'

For 2005, these geographic data elements were requested of the facilities. The defaults above were applied only where data was not provided by the facility.

MAERS tracks emissions of some pollutants that are of interest to the Great Lakes Commission (GLC), but which do not have corresponding pollutant codes in the most recent NIF pollutant code table. Emission records for the following pollutant codes are excluded:

7440508; 8052413; DICDD,TOT; DICDF,TOT; HYDFLUORO; PERFLUORO; TRICDD,TO; TRICDF,TO; CH4; CO2; N20; 117840; 7783064.

Emission records for ammonia are exported with the Chemical Abstract Service number 7664417, rather than the pollutant code NH3. These pollutant codes are updated to NH3. Likewise, records exported with pollutant codes PAH and POM are updated to pollutant codes 234 and 246, respectively.

All criteria and Hazardous Air Pollutant (HAP) emissions are reported at the process level, and the export routines reflect that in the strEmissionDataLevel field of the emission table. This field is set to null for criteria pollutant emission records per EPA guidance.

All emissions are exported as pounds of annual emissions. The EPA guidance suggests that criteria pollutant emission be reported in tons. The field strEmissionUnitNumerator is changed to TON and the filed dblEmissionNumericValue is divided by 2000 for criteria pollutant emission records.

Null values in the quarterly throughput fields of process records are set to zero.

Where quarterly throughput fields of process records sum to zero, throughput percentages are set to 25% for each quarter.

MAERS recognizes a control device code of '909' for a “Roll Media Fiberglass Tack Filter (Tacky 1 side),” which is not recognized in the NIF code tables. Where this control device code is exported, the “strPrimaryDeviceTypeCode” field of the control equipment table is updated to a value of 058.

Because of the exclusion of emission records as described above, referential integrity of the exported data can be compromised. At this point, it is re-established by deleting records stepwise, in the following order.

CE records without corresponding EM records
PE records without corresponding EM records
EP records without corresponding EM records
ER records without corresponding EP records
EU records without corresponding EP records

SI records without corresponding EU records

The data are then checked again for referential integrity and mandatory fields and then loaded into the MS Access shell version of the NIF via append queries that connect to the PostgreSQL data tables via ODBC. The Basic Content and Format Checker is run and its output is reviewed. Where corrections are needed, to assure consistency among data sources, the corrections are made in the MAERS and a full iteration of the export and post-processing steps are performed.

The 2005 point source inventory was incorporated into the LADCO Base M inventory and serve as the basis for Michigan's 2005 CERR submittal.

2008 Stationary Non-EGU Point Source Methodologies

The 2008 point source data have as their original sources the 2008 Michigan point source emission inventory. This section of the document describes the compilation and processing of point source emission data submitted to comply with CERR for the EPA NEI 2005 inventory.

The data originates with the entry of data by the reporting facilities into the MAERS. The electronic data received from the reporting facilities is reviewed and compiled by the MDEQ, and exported to the Consolidated Emissions Reporting Schema (CERS) extendible markup language (XML) text version of the EPA Emissions Inventory System (EIS). After the exported data is loaded into a PostgreSQL database patterned after the MS Access version of the CERS Staging Tables, the following processing steps and checks are performed.

Both emissions estimated by default calculations in MAERS and any emissions reported by facility operators are maintained in MAERS. For evaluation and quality assurance purposes, both types of records are included in the exports. To avoid double-counting, where a specific process/pollutant has emission records both reported directly by the facility operator and estimated via MAERS calculations, the latter are excluded.

Portable facilities such as asphalt plants report total throughput and emissions, plus operating percentages for each county in which the portable facility was located during the year. From this information, records are generated for each county of operation, and throughput and emissions are apportioned based on the operating percentages reported by county and process. As geographic coordinates for all operating sites are not reported, coordinates corresponding to the centers of the counties of operation are assigned.

As attention has shifted from total particulate to PM_{10} and $PM_{2.5}$, total particulate records are excluded from the reporting requirements.

Over 99.8% of total criteria emissions are accounted for by emissions reported by the operator, therefore exported criteria emissions estimated via MAERS calculations are excluded.

All criteria and HAP emissions are reported at the process level.

All emissions are exported as pounds of annual emissions. The EPA guidance suggests that criteria pollutant emissions be reported in tons. The CERS emissions field is converted to TONs and the emissions unit field is changed to TON.

Null values in the quarterly throughput fields of process records are set to zero.

Where quarterly throughput fields of process records sum to zero, throughput percentages are set to 25% for each quarter.

The 2008 point source inventory was incorporated into the LADCO Base B inventory and serve as the basis for Michigan's 2008 CERR submittal.

2018 and 2022 Future Year Stationary Non-EGU Point Source Methodologies

A Correlation/Regression analysis of energy demand as expressed as BTU heat input for actual year fuel consumption of years 2002-2008 obtained from MAERS was used to derive future year growth factors. The results of this analysis did not indicate any trend with time within the 7-county planning region. Future year 2018 and 2022 emission projections take into consideration a 7-year average of the BTU heat input from non-EGU sources. Additional analysis was performed at the statewide level using Energy Information Administration fuel BTU heat input data for years 2002-2008. Unlike the Southeast Michigan 7-county area, which didn't show any trend with time, the statewide correlation/regression analysis showed a declining trend with time in BTU heat input. It was found that the 7-year average BTU heat input resulted in growth factors for the 7-county area that were greater than those obtained from the statewide correlation/regression analysis.

4. Stationary Area (Non-point) Sources

2005 and 2008 Stationary Area Source Emission Inventory

The following is a description of the various area source categories that were inventoried as part of the years 2005 and 2008 emissions inventories as required by the EPA under CERR. It also provides documentation as part of the development of a broader emissions inventory (which encompasses point, area, non-road mobile, on-road mobile, and biogenic sources) that is being developed to support State Implementation Plan (SIP) requirements for attainment demonstrations.

Summary of Area Sources and Respective Air Pollutants Inventoried for 2005 Inventory

Seq #	Area Source Description	SCCs	SIC	CO	NH3	NOx	PM10-PRI	PM25-PRI	SOX	VOC
1	Residential coal	2104001000	8811	√	√	√	√	√	√	√
2	Residential distillate oil	2104004000	8811	√	√	√	√	√	√	√
3	Residential kerosene	2104011000	8811	√	√	√	√	√	√	√
4	Residential natural gas	2104006000	8811	√	√	√	√	√	√	√
5	Residential propane	2199007000	8811	√		√	√	√	√	√
6	Commercial coal	2103002000	9999	√	√	√	√	√	√	√
7	Commercial distillate oil	2103004000	9999	√	√	√	√	√	√	√
8	Commercial kerosene	2103011005	9999	√	√	√	√	√	√	√
9	Commercial natural gas	2103006000	9999	√	√	√	√	√	√	√
10	Commercial residual oil	2103005000	9999	√	√	√	√	√	√	√
11	Industrial coal	2102002000	3999	√	√	√	√	√	√	√
12	Industrial distillate oil	2102004000	3999	√	√	√	√	√	√	√
13	Industrial kerosene	2102011000	3999	√	√	√	√	√	√	√
14	Industrial natural gas	2102006000	3999	√	√	√	√	√	√	√
15	Industrial residual oil	2102005000	3999	√	√	√	√	√	√	√
16	Remedial action	2660000000	9511	√		√	√		√	√
17	Municipal landfills	2620030000	4953	√		√	√	√		√

Stationary Source Fossil Fuel Combustion

The combustion of natural gas, propane-liquefied petroleum gas (LPG), distillate fuel oil, kerosene, and residual fuel oil in small boilers, furnaces, heaters, and stoves are also a source of VOC, NOx, particulates, SO_2, and ammonia emissions. Because these sources are so numerous to be identified in point source inventories, this area source category attempts to provide a collective estimate of emissions from these smaller energy consumption sources by subtracting all fuel used by point sources from total fuel consumption. Procedures for the estimation of these smaller sources are presented in the EPA's documents entitled:

1. *Volume II, Chapter 2 of the Emission Inventory Improvement Program January 2001 Preferred and Alternate Methods for Estimating Air Emissions from Boilers.*

2. *Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract- Fuel Oil and Kerosene Combustion.*

3. *Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Natural Gas and LPG Combustion.*

4. *Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Coal Combustion.*

5. *Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) for Criteria Air Pollutants and Ammonia.*

6. Hanke, B.H, manuscript prepared for U.S Environmental Protection Agency entitled: *A National Methodology and Emission Inventory for Residential Fuel Combustion.*

This documentation involves determination of total fuel consumption over an area with subsequent fuel deductions made for point source fuel consumption, and then applying emissions factors to estimate fuel emissions.

Total fuel consumption information was based on data supplied from U.S. Department of Energy, Energy Information Administration (EIA) documents. The unaccounted fuel consumption was then apportioned to individual counties using U.S. Census Bureau information for the individual end use sector fuel types based on LADCO states methodology. Area source fuel emissions were reported for the following residential, commercial/institutional, and industrial end use sectors. Since utility boilers are accounted as point sources, area source emissions are not reported for this end use sector.

Residential Boilers & Furnaces

County emission estimates for the residential end use sector were based on the consumption of natural gas, propane-LPG, distillate fuel oil, kerosene, and coal. This energy consumption information was obtained from U.S. Department of Energy, EIA data. Since the EIA merely provides statewide fuel consumption totals, county fuel consumption estimates were obtained by apportioning the fuel consumption based on the number of year 2000 occupied household census counts using the given fuel. Emission estimates were calculated using the following mathematical equation:

$$Cf = Ch/Sh \times Sf$$

Where:

Cf = Estimated county residential sector consumption of a given fuel type for year 2005

Ch = Number of year 2000 census occupied households in a given county that utilize a given fuel type

Sh = Total number of year 2000 census occupied households statewide that utilize a given fuel type

Sf = Total statewide residential sector consumption of a given fuel type

Michigan Residential Fuel Consumption Information Sources

Residential Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Propane LPG	Petroleum Marketing Annual, 2005, Table 49: Prime Supplier Sales Volumes of Aviation Fuels, Propane and Residual Fuel Oil by PAD District and State
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 19: Adjusted Sales for Residential Use: Distillate Fuel Oil and Kerosene, 2005
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

Upon obtaining county residential fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were obtained from various EPA publications.

Michigan Residential Fuel Emission Factors

Residential Fuel Type	Units	CO	NH_3	NOx	PM_{10}-PRI	PM_{25}-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	40	0.49	94	7.6	7.6	0.6	5.5
Propane LPG	Lbs/1,000 gal	3.2		13	0.68	0.68	0.1	0.5
Distillate fuel oil	Lbs/1,000 gal	5.0	0.8	18	2.38	2.13	42.60	0.7
Kerosene	Lbs/1,000 gal	4.8	0.8	17.4	2.38	2.13	41.1	0.7
Coal	Lbs/ton	275	0.000565	3.0	18.63	4.86	37.83	10

Sources of Emission Factors:

1. U.S. Environmental Protection Agency *Documentation for the Draft 1999 National Emissions Inventory (Version 3.0) for Criteria Air Pollutants and Ammonia.*

2. Hanke, B.H, manuscript prepared for U.S Environmental Protection Agency entitled: *A National Methodology and Emission Inventory for Residential Fuel Combustion.*

3. U.S. Environmental Protection Agency. Final Report on *Development and Selection of Ammonia Emission Factors.*

The resulting emission estimates were reported by individual fuel type using the following SCC codes:

Michigan Residential Combustion Emission SCC Codes

Residential Fuel Type	SCC
Natural gas	2104006000
Propane LPG	2199007000
Distillate fuel oil	2104004000
Kerosene	2104011000
Coal	2104001000

Commercial/Institutional Boilers and Furnaces

Estimation of fuel combustion by the commercial/institutional sector was performed using an adaptation of a methodology presented in the following EPA publications:

1. *Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract- Fuel Oil and Kerosene Combustion*

2. *Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Natural Gas and LPG Combustion*

3. *Emission Inventory Improvement Program –April 6, 1999, Area Source Category Abstract-Coal Combustion*

County emission estimates for the commercial/institutional end use sector were based on the consumption of natural gas, residual fuel oil, distillate fuel oil, kerosene, and coal. This energy consumption information was obtained from U.S. Department of Energy, EIA data. Fuels were subtracted for point sources, and the net area fuel contribution was apportioned or allocated using procedures instructed by LADCO. This procedure involved statewide commercial/institutional fuel apportionment to a county level using the commercial/institutional employment data as obtained from U.S. Department of Commerce, Bureau of Census publication entitled *County Business Patterns, Michigan: 2003* (CBP/03-24 issued September, 2005). County fuel estimates of individual fuel types were estimated using the following equation:

$$Cf = Ce/Se \times Sf$$

Cf = Estimated county commercial/institutional sector consumption of a given fuel type
Ce = Total county employment in the commercial/institutional sector
Se = Statewide employment in commercial/institutional sector
Sf = Statewide commercial/institutional sector consumption of a given fuel type

Because the Energy Information data includes diesel fuel totals within the distillate fuel oil total, these motor vehicle fuels were deducted to provide only an estimate of #1, #2, and #4 fuel oils.

Michigan Commercial/Institutional Fuel Consumption Information Sources

Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Residual fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 17: Adjusted Sales of Residual Oil by Energy Use, 2004 and 2005
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 20: Adjusted Sales for Commercial Use: Distillate Fuel Oil, Residual Fuel Oil and Kerosene 2005
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26 U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

Upon obtaining county commercial/institutional fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were obtained from various EPA publications.

Michigan Commercial/Institutional Fuel Emission Factors

Commercial/Institutional Fuel Type	Units	CO	NH_3	Nox	PM_{10}-PRI	PM_{25}-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	84	0.49	100	7.6	7.6	0.6	5.5
Residual fuel oil	Lbs/1,000 gal	5	0.80	55	9.07	3.37	194.05	1.13
Distillate fuel oil	Lbs/1,000 gal	5	0.80	20	2.38	2.13	53.96	0.34
Kerosene	Lbs/1,000 gal	5	0.80	18	2.38	2.13	41.1	0.713
Coal	Lbs/ton	6	0.000565	7.5	6.0	2.2	36.86	0.05

Sources of Emission Factors:

1. LADCO state uniform adopted emission factors for commercial/institutional natural gas combustion.

2. U.S. Environmental Protection Agency. FIRES database.

3. U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42).*

4. U.S. Environmental Protection Agency. Final Report on *Development and Selection of Ammonia Emission Factors.*

The resulting emission estimates were reported by individual fuel type using the following SCC codes:

Michigan Commercial/Institutional Combustion Emission SCC Codes

Fuel Type	SCC
Natural gas	2103006000
Residual fuel oil	2103005000
Distillate fuel oil	2103004000
Kerosene	2103011005
Coal	2103002000

Industrial Boilers and Furnaces

Estimation of fuel combustion emissions of industrial boilers and furnaces was performed in similar manner as the commercial/institutional sector. Statewide industrial fuel consumption information was obtained from the U.S. Department of Energy, EIA publications. Point source deductions were made for each fuel type to obtain the area contribution that was then apportioned to the county level using LADCO prescribed procedures.

County fuel consumption estimates of natural gas, residual fuel oil, distillate fuel oil, kerosene, and coal were based upon the following mathematical equation:

$$Cf = Ce/Se \times Sf$$

Cf = Estimated county industrial sector consumption of a given fuel type
Ce = Total county employment in the industrial sector
Se = Statewide employment in industrial sector
Sf = Statewide industrial sector consumption of a given fuel type

Michigan Industrial Fuel Consumption Information Sources

Industrial Fuel Type	U.S. Dept of Energy, EIA Data Sources
Natural gas	Natural Gas Annual 2005, Michigan Table 48
Residual fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 17: Adjusted Sales of Residual Oil by Energy Use, 2004 and 2005
Distillate fuel oil	Fuel Oil and Kerosene Sales 2005 Report, Table 21: Adjusted Sales for Industrial Use: Distillate Fuel Oil, Residual Fuel Oil, and Kerosene (#1, #2, and #4 fuel oils – excludes diesel oil)
Kerosene	Fuel Oil and Kerosene Sales 2005 Report, Table 18: Adjusted Sales of Kerosene by Energy Use
Coal	EIA Annual Coal Report 2005, Table 26: U.S. Coal Consumption by End Use Sector, by Census Division and State 2005, 2004 (Thousand Short Tons)

County employment data was obtained from the U.S. Department of Commerce, Bureau of Census publication entitled *County Business Patterns, Michigan: 2003 (CBP/03-24 issued September, 2005)*. Upon obtaining county industrial fuel consumption estimates for the various fuel types in all Michigan counties Cf, emission estimates were obtained by applying an emission factor that is specific to that fuel type. These emission factors were generally based on the LADCO adopted emissions factors.

Michigan Industrial Fuel Emission Factors

Industrial Fuel Type	Units	CO	NH_3	NOx	PM_{10}-PRI	PM_{25}-PRI	SO_2	VOC
Natural gas	Lbs/million cubic feet	84	3.2	100	7.6	7.6	0.6	5.5
Residual fuel oil	Lbs/1,000 gal	5.0	0.8	55	7.17	4.67	157	0.28
Distillate fuel oil	Lbs/1,000 gal	5.0	0.8	20	2.3	1.55	53.96	0.2
Kerosene	Lbs/1,000 gal	5.0	0.8	18	2.38	2.13	41.1	0.713
Coal	Lbs/ton	6	0.00057	7.5	6.0	2.2	38	0.05

Sources of Emission Factors:

1. LADCO state uniform adopted emission factors for industrial natural gas, residual fuel oil, distillate fuel oil, and coal combustion.
2. U.S. Environmental Protection Agency. FIRES database.
3. U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42).*
4. U.S. Environmental Protection Agency. Final Report on *Development and Selection of Ammonia Emission Factors.*

Emission estimates were reported using the following SCC codes:

Michigan Industrial Combustion Emission SCC Codes

Industrial Fuel Type	SCC
Natural gas	2102006000
Residual fuel oil	2102005000
Distillate fuel oil	2102004000
Kerosene	2102011000
Coal	2102002000

Remedial Action, Site Clean Up & Leaking Storage Tanks

Evaporative VOC emissions occur during remediation and cleanup at sites of environmental contamination. Such remediation activities may include air stripping or sparging of a VOC from contaminated groundwater or incineration of a spoil material removed from a contaminated site. In some instances carbon adsorption may be required to reduce VOC emitted during air stripping or spraying operations.

Estimation of VOC loss from remedial action activities was determined by summing the allowable emissions from permits to those parties that were engaged in such activities as provided by the MDEQ, Air Quality Division (AQD), Permit Section. Although site remediation activities are subject to NESHAPs, these requirements did not apply at the time of the year 2005 emissions inventory. Emissions were reported using an SCC of 2660000000.

Municipal Waste Landfills

A municipal solid waste landfill is defined as any facility that is regulated under Subtitle D of the Resource Conservation and Recovery Act (RCRA) that receives primarily household and/or commercial wastes.

VOCs are produced from municipal solid waste by: the volatilization of the waste material itself, the microbiological (anaerobic) putrefaction of organic waste materials that result in the formation of organic acids and alcohols that are vaporized, and the chemical reaction of one or more waste materials or chemical decomposition intermediate. The rate at which VOCs are emitted from a landfill is dependent upon the structural design of cells, the waste composition (physical/chemical properties), the moisture content of the waste, the amount of waste disposed, temperature, age of the landfill, the chemical reactivity of the waste, the microbiological toxicity of the waste, and the effectiveness of landfill gas collection systems. Where landfill gas is collected for use in boilers, internal combustion engines (reciprocating and turbines) or flared at the landfill site, there are additional air pollutants such as NOx, particulates ($PM_{2.5}$ and PM_{10}), and carbon monoxide produced from incomplete combustion.

Estimation of VOC emissions from municipal landfills were based on the revised technical procedures presented in the EPA publication entitled: *Volume III, Chapter 15 of the Emission Inventory Improvement Program January 2001 Revised Final Guidance for Landfills*. In this publication, the preferred method for the estimation of area source emissions is to use the LandGem model or the equations from the *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, 5th Edition and Supplements (AP-42)* section on landfills. LandGem is a computer-based model that uses the same equations as that of AP-42. The emissions calculation for the estimation of landfill gas requires site specific information including: landfill design capacity, accumulated waste totals from operation of the landfill, and existing control requirements from landfill gas collection systems. Landfills may be subject to either new source performance standards (*40 Code of Federal Regulations Part 60 Subpart WWW*) or emission guidelines (*40 Code of Federal Regulations, Part 60, Subpart Cc*). Landfills are now also subject to NESHAPs that became effective on January 16, 2003. For those landfills that were not being reported in the point source inventory, area emission estimates were reported on the basis on LandGem model simulations using the SCC of 2620030000. These simulations reflected total waste receipts under the prior year 1999 inventory with addition made for waste receipts for years 2000-2005 as obtained from annual reports by the *MDEQ, Waste and Hazardous Division Report of Solid Waste Landfilled in Michigan*. For those landfills that operated landfill gas collection/combustion systems, emission estimates considered Tables 2.4-3 and 2.4-5 of AP-42 with adjustments considered for a landfill gas methane collection efficiency of 75% of LandGem model predicted methane generation at a given landfill site.

Non-Methane Organic Compound Control Efficiencies for Landfill Gas Combustion from AP-42

Combustion Control Device	Typical Control Efficiency (%)
Boilers	98
Flares	99.2
Gas Turbines	94.4
IC Engine	97.2

Emission Rates for Secondary Compounds from Landfill Gas Combustion (Based upon lbs/ Million Cubic Feet of Landfill Gas Combusted)

Combustion Control Device	NOx	$PM_{2.5}$-PRI	PM_{10}-PRI	CO
Flare	40	17	17	750
IC Engine	250	48	48	470
Boiler	33	8.2	8.2	5.7
Gas Turbines	87	22	22	230

Open Burning: Municipal Solid Waste

For the category of open burning of municipal solid waste (MSW), EPA's methodology from Appendix A of *Documentation for the Final 2002 Nonpoint Sector (Feb 06 Version) National Emission Inventory for Criteria and Hazardous Air Pollutants* was followed. The ratio of urban to rural population was obtained from 2000 U.S. Census data, per the EPA's method, then multiplied by a 2005 U.S. Census Bureau estimate of the county population in Michigan to obtain an estimate of rural population in 2005. Per capita emission factors were used, after first excluding those counties where the population was greater than 80% urban under EPA's presumption that open burning of MSW would not occur there.

Outdoor Wood Boilers

The Wisconsin methodology distributed by Bart Sponseller was followed. Per that methodology, the MARAMA emission factor of 13.82 g/kg wood burned was used.

An estimate of 11.68 cords/yr/unit in Michigan was obtained from Brian Brady, AQD. Brian serves as the AQD's outdoor wood boiler expert.

Michigan estimated an average weighted density of 1.65 tons/cord of wood, based on information contained within Table 8 of the USDA survey report *Residential Fuelwood Consumption and Production in Michigan, 1992*.

Per the Wisconsin methodology, it was assumed that 90% of outdoor wood boilers are used in rural areas and 10% are used in urban areas. To determine which counties were urban and which were rural, staff reviewed the list of counties, which are part of Michigan's Consolidated Statistical Areas (metropolitan areas) and determined that the 22 affected counties should be considered as urban. Ten percent of the 29,568 Michigan outdoor wood boilers were apportioned to the urban counties by population. The remaining 90% of the outdoor wood boilers were apportioned to the 61 rural counties by population.

2005 Residential Wood Burning

Michigan utilized the EIIP methodology's alternative method for estimating emissions from residential wood burning, by apportioning data from the U.S. Census Bureau and the EIA.

Two options were available to estimate wood burning households per county.

- Housing Units with Wood Heat by County was determined by using 1990 U.S. Census Data, Database C90STF3C1, Summary Level State, for House Heating Fuel for Occupied Housing Units (http://venus.census.gov/cdrom/lookup). Although this data is for the 1990 year, it did provide a value for each county.

- Housing Units with Wood Heat by County was determined by using the U.S. Census Bureau's DP-4, Profile of Selected Housing Characteristics: 2000, Data Set: Census 2000 Summary File 3 (SF 3) for Michigan. This file provided a *total* value of households using wood heating. However, no breakdown was given by county.

The AQD staff used the 2000 number of total wood burning households in Michigan, and used the 1990 county proportions of the 1990 total to apportion the 2000 value to the county level.

Then based on county value for number of wood burning households, the value for state wood use in cords was apportioned to each county. The 2003 state wood use in cords data came from the US MAP States Page, *Table 8, Residential Energy Consumption Estimates, Selected Years 1960-2003, Michigan*, from the U.S. Department of Energy, EIA:

http://www.eia.doe.gov/emeu/states/sep_use/res/use_res_mi.html

Data for 2005 was not available at the time the 2005 inventory was developed.

Once county wood use in cords was produced, the next step was to determine the wood weight in tons for each county. Wood weight was determined by estimating a weighted average wood weight of 1.65 tons per cord, from species and consumption data from Table 8 of the USDA report, "Residential Fuelwood Consumption and Production in Michigan, 1992."

Michigan did not have data available on the number of catalytic and non-catalytic woodstoves in Michigan, but did utilize 1993 survey data which showed the proportions of fireplaces to woodstoves by county in Michigan. This was used to apportion wood weight per county between wood stoves and fireplaces. SCCs and emission factors were selected for fireplaces – cordwood (2104008001), and woodstoves – general (2104008010).

No ozone season activity was estimated, as staff felt it was unlikely that residents would utilize their fireplaces or wood stoves between June 1 and August 31 of each year.

FIRE 6.23 and Source Summary Database (SSD) list the following Area Mobile Source Codes (AMS):

A2104008000: Total wood stoves and fireplaces
A2104008001: (lb/ton dry wood burned): Fireplaces - general
A2104008010: (mg/Mg dry wood burned): Wood stoves - general
A2104008030: (lb/ton dry wood burned): Catalytic wood stoves - general
A2104008050: (lb/ton dry wood burned): Non-catalytic wood stoves - general
A2104008051: (lb/ton dry wood burned): Non-catalytic wood stoves - conventional
A2104008052: (lb/ton dry wood burned): Non-catalytic wood stoves - low emitting
A2104008053: (lb/ton dry wood burned): Non-catalytic wood stoves - pellet fired

Michigan selected AMS codes A2104008001 and A2104008010. These were the most appropriate codes, as data exists for the proportion of woodstoves to fireplaces per county in Michigan, but data was not available on numbers of catalytic or non-catalytic wood stoves. Emission factors for A2104008010 were converted from mg/Mg to lb/ton by multiplying by the conversion factor of 2.00E-06.

References:

1. EPA, *Factor Information Retrieval System Version 6.23*, U.S. Environmental Protection Agency, 2000.

2. EPA, STAPPA, ALAPCO, *Emission Inventory Improvement Program (EIIP)*, Volume III, July 1997, Chapter 2.

2008 Residential Wood Combustion

Michigan utilized the EPA's Residential Wood Combustion tool (RWC_2008_Toolv4.1) to estimate emissions from Residential Wood Combustion for the 2008 emissions inventory. The residential wood combustion tool was modified to address a few deficiencies with Michigan Counties. Double-counting of emissions for SCCs 2104008400, 21048510, and 2104008610 was resolved, and the allocation of appliances for SCC 2104008610 Hydronic heater: outdoor was revised using an inverse population density methodology.

Structure Fires

The EIIP guidance from EIIP Volume III, Chapter 18: *Structure Fires*, was followed. The preferred method for estimating emissions was used, due to the availability of county level structure fire data for 2002. More recent data was not available; the fire statistics data, which was originally kept by the Michigan State Police Fire Marshall Division, is now kept by the Michigan Department of Labor and Economic Growth. DLEG staff were unable to locate more recent county level data on structure fires. The 2002 data

was re-used from the 2002 area source submittal. However, it did not provide any detail on the extent of each structure fire, or indicate if the structure was residential or commercial.

The default fuel loading factor provided in the EIIP guidance (1.15 tons of fuel per structure fire) was used. Emission factors for VOC, CO, and NOx were obtained from Table 18.4-1.

Year 2018 and 2022 Stationary Area Source Emission Inventory Projections:

Area sources represent those emission sources that do not report to MAERS. Future year projections take into consideration the corresponding BTU heat input from residential, commercial/institutional, and unaccounted industrial sources. Residential projections considered SEMCOG forecast of expected number of households within the 7-county area. Similarly, regional economic employment forecast from SEMCOG projections was used to derive the non-manufacturing sector employment growth for the 7-county area. For unaccounted industrial sources, growth rates were assumed to be similar as Non-EGU source projections.

5. Non-Road Mobile Sources

Non-Road Emissions Estimation Exclusive of Locomotive, Shipping, and Aircraft Emissions

Non-road equipment population and emission estimates for 2005, 2008, 2018, and 2022 were obtained from the EPA NONROAD2008a model to simulate winter weekday and annual PM2.5, SO2, and NOx emissions. The updated model and technical support documentation can be obtained from: http://www.epa.gov/otaq/nonrdmdl.htm . Fuel property information utilized in LADCO regional emission simulations were from Grant Hetherington of the State of Wisconsin and from EPA NONROAD2008 model documentation.

2005 and 2008 Aircraft Emissions Estimation

To estimate aircraft emissions, aircraft activity was obtained for Michigan airports. Historically this information was obtained from MDOT. However, MDOT was unable to provide updated information for year 2005. In the absence of updated MDOT 2005 aircraft activity data, commercial aircraft and commercial air freight departure information by aircraft model type was obtained from Federal Aviation Administration (FAA) airport records. For determining airport LTO cycles, the Air Traffic Activity Data System (ATADS) air traffic count database of larger towered airports, Terminal Area Forecast (TAF) air traffic operations database of towered and non-towered airports, and G.C.R. & Associates airport activity data were used. Since ATADS provides aircraft operations for a limited number of the states' airports, TAF aircraft operations estimates were considered where ATADS information was unavailable. G.C.R. & Associates, Inc. consultant data was used for the smaller airports of which FAA aircraft operations information was unavailable. The following information from the respective sources was considered in the development of emission estimates:

1. Commercial scheduled and non-scheduled aircraft air carrier activity and commercial air freight activity by aircraft model types;

2. General aviation and air taxi annual local and itinerant operations for year 2005;

3. Military annual local and itinerant operations for year 2005. Due to need to have aircraft operations information expressed as LTO cycles, the following assumptions were made:

    a. For commercial aircraft and commercial air freight activity, the number of annual aircraft annual LTO cycles was assumed to be equal to the number of departures. The daily LTO cycle frequency was then obtained by dividing the yearly LTO cycles by 365.

b. For general aircraft annual local and itinerant airport operations, each respective operations total was divided by two to obtain the corresponding year local and itinerant LTO cycles. The expected daily local and itinerant LTO cycles then were obtained by dividing these annual totals by 365.

c. For military annual local and itinerant operations, each respective operations total was divided by two to obtain the corresponding year local and itinerant LTO cycles. The expected military daily local and itinerant LTO cycles then were obtained by dividing these annual totals by 365.

Airport LTO cycles were further categorized into commercial aircraft by plane and engine type, general aviation itinerant aircraft of unknown aircraft type, general aviation local aircraft of unknown aircraft type, and military aircraft. This was necessary to utilize the U.S. Department of Transportation, FAA Emissions and Dispersion Modeling System 4.5 (EDMS). A description of this model can be found in the FAA publication entitled, *Emissions and Dispersion Modeling System (EDMS) User Manual* (September 2004). Commercial and air freight aircraft emission factors per LTO cycle were determined using EDMS 4.5 for each commercial aircraft type models where possible were used at each towered airport. Default commercial aircraft engine type, and EPA default time in mode values for takeoff, approach, and landing roll times were used in the EDMS 4.5 model simulations.

For those aircraft types that could not be determined using the EDMS 4.5 emissions model, aircraft emission factors based on EPA alternative fleet average procedures were then used to estimate their emissions. These included general aviation and air taxi itinerant aircraft of unknown aircraft type, general aviation local aircraft of unknown aircraft type, and military aircraft. Conversion from total hydrocarbons to VOC was performed and based on the EPA guidance.

Aircraft emissions were then obtained by adding emissions contributions from commercial, itinerant general, and local general aircraft, and were reported using the following SCC codes:

Michigan Aircraft Emission SCC Codes

Aircraft Type	SCC
Military	2275001000
Commercial	2275020000
General Aviation	2275050000

2005 Locomotive and Shipping Emissions Estimation

The 2005 non-road shipping and locomotive emissions were prepared using the same techniques used for the 2002 emissions. These estimates are based on work and a follow-up report (Environ Report for LADCO, *2002 Shipping Emissions Sources,* April 2004) completed by Environ to support LADCO's efforts to prepare a 2002 Air Emissions Inventory. The report describes Environ efforts to develop a shipping 2002 air emissions estimates to support air quality modeling. The Environ report is too long to be included in this document, but it can be provided upon request or downloaded at:

http://ladco.org/reports/rpo/MWRPOprojects/Emissions/Environ_Final_Report_non-road.pdf

The estimate of 2005 locomotive and shipping emissions was made by LADCO in the same manner as the 2002 inventory described above. The 2005 estimates are part of LADCO's Base M inventory.

2008 Locomotive, Shipping, and Aircraft Emissions Estimation

The 2008 emissions are based on work and a follow-up report (E.H. Pechan & Associates, Inc., *Development of Growth and Control Factors for Lake Michigan Air Directors Consortium*, Final Report, December 14, 2004) done by E.H. Pechan & Associates, Inc. (Pechan). This work supports LADCO's efforts to forecast anthropo-genic emissions for the purpose of assessing progress for air quality goals, including goals related to regional haze and attainment of the ozone NAAQS. The Pechan growth factors were used to estimate the LADCO Base M future year emissions posted by LADCO in 2007. The future year emissions represent both emission controls that already exist and those that are known to be on the way.

Non-road Mobile Source Emission Inventory Projections to 2018 and 2022

The non-road source categories exclusive of locomotive, shipping, and aircraft were grown in the EPA Mobile source model NMIM. The locomotive, shipping, and aircraft non-NMIM source categories were grown using growth factors provided in the report, *Development of Growth and Control Factors for Lake Michigan Air Directors Consortium,* Final Report, December 14, 2004*,* prepared by Pechan for LADCO and available upon request.

See **Growing Stationary Non-EGU Point, Stationary Area, Locomotive, Shipping, and Aircraft Categories for the Years 2018 and 2022** in the **Non-EGU Point Sources** section for references and methodology for projecting the Locomotive, Shipping and Aircraft emissions inventory.

6. On-road Mobile Sources

Please refer to the On-road Mobile Source Emissions Inventory for Southeast Michigan – $PM_{2.5}$ Redesignation Request, January 27, 2011, prepared by SEMCOG, and contained in Appendix C.